Organophosphorus Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets

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We assessed organophosphorus (OP) pesticide exposure from diet by biological monitoring among Seattle, Washington, preschool children. Parents kept food diaries for 3 days before urine collection, and they distinguished organic and conventional foods based on label information. Children were then classified as having consumed either organic or conventional diets based on analysis of the diary data. Residential pesticide use was also recorded for each home. We collected 24-hr urine samples from 18 children with organic diets and 21 children with conventional diets and analyzed them for five OP pesticide metabolites. We found significantly higher median concentrations of total dimethyl alkylphosphate metabolites than total diethyl alkylphosphate metabolites (0.06 and 0.02 µmol/L, respectively; $p = 0.0001$). The median total dimethyl metabolite concentration was approximately six times higher for children with conventional diets than for children with organic diets (0.17 and 0.03 µmol/L; $p = 0.0003$); mean concentrations differed by a factor of nine (0.34 and 0.04 µmol/L). We calculated dose estimates from urinary dimethyl metabolites and from agricultural pesticide use data, assuming that all exposure came from a single pesticide. The dose estimates suggest that consumption of organic fruits, vegetables, and juice can reduce children's exposure levels from above to below the U.S. Environmental Protection Agency's current guidelines, thereby shifting exposures from a range of uncertain risk to a range of negligible risk. Consumption of organic produce appears to provide a relatively simple way for parents to reduce their children's exposure to OP pesticides. *Key words:* **biological monitoring, dialkylphosphates, diet, organic, organophosphorus pesticides, preschool children, produce.** *Environ Health Perspect* **111:377–382 (2003). doi:10.1289/ehp.5754 available via** *http://dx.doi.org/* **[Online 31 October 2002]**

Reduction of children's risk from pesticides requires an understanding of the pathways by which exposure occurs. Aggregate exposure models that integrate all exposure pathways have been developed by the U.S. Environmental Protection Agency (U.S. EPA) since passage of the Food Quality Protection Act of 1996 (FQPA; 1996). Such models require an understanding of each source, exposure pathway, and exposure route, and they aim, in part, to identify the pathways and routes that are the most significant contributors to children's overall pesticide dose.

Dietary ingestion is one of the pathways by which children are exposed to pesticides (Akland et al. 2000; Berry 1997; ILSI 1999; Thomas et al. 1997). Children eat more food per body mass than adults, and their diets differ from those of adults. These diets are often rich in foods containing higher levels of pesticide residues, such as juices, fresh fruits, and fresh vegetables (National Research Council 1993). Several national programs monitor pesticide levels in the food supply (FDA 1996; USDA 1997), and at least two studies have examined pesticide levels in duplicate diets of children (Fenske et al. 2002; Melnyk et al. 1997). Recent work has indicated that children's diets may contain pesticides at levels above the acute population-adjusted reference dose (Fenske et al. 2002).

Consumption of foods grown organically is often perceived to reduce risk by reducing exposure to pesticide residues (Williams and Hammit 2001). Organic produce is grown without the use of many synthetic agricultural products, including most conventional pesticides (USDA 2001). A recent study of 110 urban and suburban children found measurable levels of organophosphorus (OP) pesticide metabolites in the urine of all children sampled, except for one child whose parents reported buying exclusively organic produce (Lu et al. 2001). This finding suggested that conventionally grown produce might be a primary source of pesticide exposure for urban and suburban children. No studies to date have examined this issue.

Our objective in this study was to compare OP pesticide metabolite levels in the urine of preschool children ages 2–5 years whose diets included either mostly organic or mostly conventional juices, fresh fruits, and fresh vegetables. OP pesticides were selected for analysis because of their widespread use, their reported presence as residues on foods frequently consumed by children, and their acute toxicity (FDA 1996; Fenske et al. 2002; MacIntosh et al. 2001; USDA 1997; WHO 1986).

Methods

Sample population. Subjects were recruited from the entryways of two grocery stores in the Seattle, Washington, metropolitan area: a local consumer cooperative selling a large variety of organic foods and a large retail chain supermarket selling mostly conventional foods. These stores were selected because they tend to serve clientele with similar socioeconomic status (middle to upper-middle class). With permission of the store managers, customers were approached at the store entrances and asked about their interest in the study. Those who had toilet-trained children in the 2–5-year-old age range were asked about their children's diets. Children whose parents stated that their juice, fresh fruit, and fresh vegetable consumption was either nearly all organic or nearly all conventional were eligible for the study. Enrollment was limited to one child per household. On the basis of the population variance and mean urinary dialkylphosphate (DAP) concentrations found in a previous study of pesticide exposure to children in the Seattle metropolitan area (Lu et al. 2001), we calculated that a sample size of 40 would yield a power of 0.80 at a 0.05 significance level.

Subjects agreed to two home visits spaced four days apart. Home visits occurred in June and July 2001. Researchers reiterated the purpose and protocol of the study at the first visit and obtained written consent from each parent and verbal assent from each child. In a few instances, the child was not available during the visit, so the parent obtained the child's assent at a later time. Parents were provided with a detailed study protocol, a food diary form, a urine collection form, and urine collection containers. Urine samples, urine collection forms, and completed food diaries were collected during the second visit, and families were provided

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